THE MORPHOLOGY AND DEVELOPMENT OF SPECIES OF *MARSSONELLA* AND *PSEUDOTEXTULARIELLA* FROM THE CHALK OF ENGLAND

by TOM BARNARD

ABSTRACT. The morphology and stratigraphical importance of species of *Marssonella* and *Pseudotextulariella* from the Chalk of England are discussed. The type specimens of *Pseudotextulariella* preserved in the Cushman collection have been re-examined. This genus from the Cenomanian has been re-studied particularly in relation to the internal structures, which are re-described. The relationships of several conical arenaceous Foraminifera are discussed.

IN 1953 the author (*in* Barnard and Banner 1953) described species of *Marssonella* and *Pseudotextulariella* from parts of the Chalk succession in England. These species were not dealt with in any detail, but formed part of a general paper on faunas from the Chalk, no emphasis being laid on their relative stratigraphical importance. Abundant new material has become available to the author and a more complete account of the morphology, development, and occurrence of these two genera may now be given. Much new evidence has been found concerning the detailed structure of *Pseudotextulariella cretosa* (Cushman), and its relationships and derivations may be discussed.

The present work was carried out during the tenure of a Leverhulme Fellowship, which enabled the author to visit the U.S.A. and study Cushman's specimens in the Smithsonian Institution, Washington. The author is grateful to Dr. C. A. Cooper for access to these specimens. The author wishes to acknowledge a grant from the Central Research Fund, University of London, which enabled him to collect additional material from a number of localities in southern and eastern England.

Specimen numbers with the prefix P indicate specimens in the British Museum (Natural History) collections.

SYSTEMATIC DESCRIPTIONS

Genus MARSSONELLA Cushman 1933

Genotype. Textularia trochus d'Orbigny.

Gaudryina oxycona Reuss 1860 (designated by Cushman 1933*a*, p. 36; 1933*b*, p. 121) is a synonym of *Textularia trochus* d'Orbigny 1840, p. 45, pl. 4, figs. 25, 26, which predates *Gaudryina oxycona* Reuss 1860 and was redesignated genotype by Barnard and Banner 1953, p. 204.

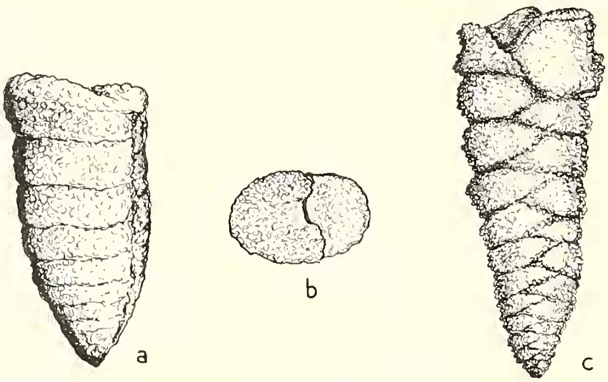
Marssonella ozawai Cushman

Text-figs. 1*a–c*

1936 *Marssonella ozawai* Cushman, p. 43, pl. 4, figs. 10*a*, *b*.
1937 *Marssonella ozawai* Cushman, p. 59, pl. 6, fig. 18.
1953 *Marssonella ozawai* Cushman; Barnard (*in* Barnard and Banner), p. 205, pl. 19, figs. 2*a*, *b*.

[Palaeontology, Vol. 6, Part 1, 1963, pp. 41–54, pl. 7.]

Description. Conical test, almost circular in cross-section. The test is coarsely arenaceous, composed of a mosaic of almost equal-sized quartz grains, with little calcareous cement. These grains protrude through the cement so that the surface of the test is rugose. A globular proloculum is followed by one to three whorls of three to five small crescentic or reniform chambers. The test then becomes biserial, the height of the chambers increases slowly, but the diameter increases rapidly, so that initially the edges of the test diverge up to an angle of 60°. After this stage, which sometimes continues up to about half the height of the test, the diameter of the test may remain almost constant giving a cylindrical late portion. Rarely the diameter increases rapidly giving a pseudo-flange to the later chambers, or it may increase slowly producing a large conical test.



TEXT-FIG. 1. *Marssonella ozawai* Cushman. All specimens from the Cenomanian. *a*, *b*, From the Portsdown borehole, 1055–1060 feet, P45013. *c*, From the marls 4 feet above 'Chloritic Marl', Arlsey, Bedfordshire, P45014. All specimens ×90.

The septa are almost flat in some varieties, but often become slightly constricted and indented, sometimes near the apertural end or occasionally the whole of the biserial portion. The apertural faces vary from almost flat, in the commonest variety, to either slightly convex or, in rare specimens, concave. Generally the apertural faces are reniform in shape. The basal aperture varies from slit-like to reniform in shape. The test is usually straight, but occasionally may be slightly arcuate or even arranged in several stages. At certain levels, long slender almost cylindrical variants occur.

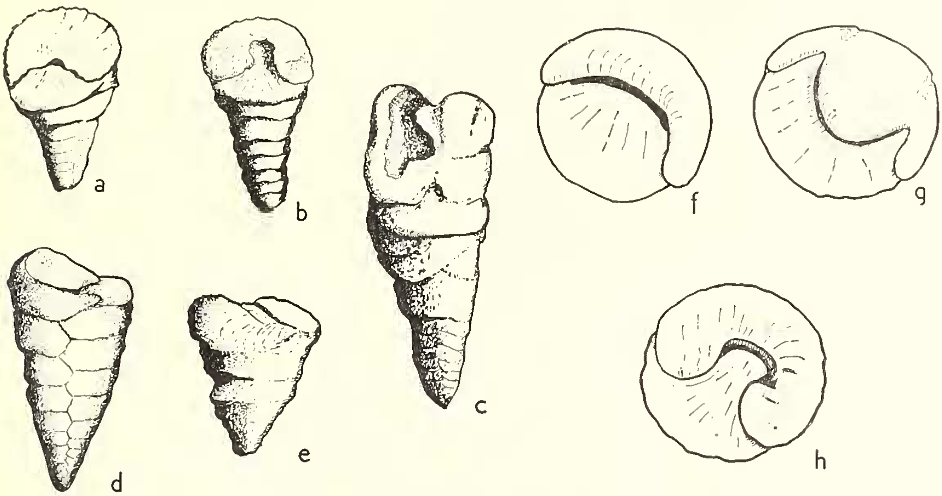
Localities. Numerous.
Horizon. Schloenbachia varians zone.
Dimensions and hypotypes. P45013 (text-figs. 1*a*, *b*). Height 0·99 mm., diameter 0·49 mm. P45014 (text-fig. 1*c*). Height 1·33 mm., diameter 0·57 mm.

Marssonella turris (d'Orbigny)

Text-figs. 2*a–h*

1840 *Textularia turris* d'Orbigny, p. 46, pl. 4, figs. 27, 28.
1890 *Textularia turris* d'Orbigny; Burrows, Sherborn, and Bailey, p. 553, pl. 8, fig. 15.
1928 *Textularia turris* d'Orbigny; Franke, p. 131, pl. 12, fig. 3.
1937 *Textularia turris* d'Orbigny; Cushman, p. 58, pl. 5, fig. 28; pl. 6, figs. 1, 2, (5?).
1957 *Marssonella turris* (d'Orbigny); Hofker, p. 83, text-figs. 84*a–e*, 85*a–e*.

Description. The test is generally a long narrow cone, which can vary to almost cylindrical, or to a cone with an apical angle of about 60°. The size of the test varies considerably, and also the rugosity of the wall. Usually the test is composed of a mosaic of small equi-dimensional quartz grains set in a moderate amount of calcite cement. Occasionally at certain horizons large quartz grains are cemented with little calcite. The quartz grains are usually almost flush with the surface of the test, but when large grains are present they are not deeply set in the cement, but protrude so that the surface is rough. Often in forms with the coarser test, grains of minerals other than quartz are included, such as glauconite, ilmenite, &c.



TEXT-FIG. 2. *Marssonella turris* (d'Orbigny). *a–e*, Showing variation in shape of the test, from the Cenomanian, *Schloenbachia varians* zone, from Sundon, near Dunstable, Bedfordshire, P45016, ×90. *f–h*, Showing the variation in the shape of the apertural face and the position of the aperture.

Variations occur in the shape of the test. Occasionally there are breaks in the normal growth-rate which give the appearance of rejuvenation. Later chambers are often ill-formed or damaged, growth is irregular, and the tests appear to be flanged. Sometimes the tests are slightly arcuate. A globular or hemispherical proloculum is followed by two or three whorls of three to five crescentic chambers which show little or no increase in height. This stage in the growth of the test is difficult to interpret. A biserial stage is soon reached and continues throughout the test. The sutures are straight and scarcely visible except in decorticated specimens, or in the end-chambers of the tests, where they may be constricted, ribbed, or flush with the surface of the test. The apertural face varies from crescentic to reniform in shape, and from highly convex to flat. Occasionally furrows run down the apertural face towards the aperture. The aperture is either slit-like, crescentic, or reniform.

Localities. Numerous.
Horizon. Cenomanian–Lower Senonian.
Dimensions and hypotypes. P45016 (text-figs. 2*a–e*). *a*, Height 0·46 mm., diameter 0·38 mm. *b*, Height 0·49 mm., diameter 0·38 mm. *c*, Height 0·87 mm., diameter 0·46 mm. *d*, Height 0·68 mm., diameter 0·42 mm. *e*, Height 0·46 mm., diameter 0·42 mm.

Marssonella trochus (d'Orbigny)

Text-figs. 3*a–q*

1840 *Textularia trochus* d'Orbigny, p. 45, pl. 4, figs. 25, 26.
1854 *Textularia conulus* Reuss, p. 72, pl. 26, figs. 7*a*, *b*.
1860 *Gaudryina oxycona* Reuss, p. 229, pl. 12, fig. 3.
1891 *Textilaria* cf. *conulus* Reuss; Beissel, p. 68, pl. 13, figs. 23–29.
1899 *Gaudryina oxycona* Reuss; Egger, p. 38, pl. 4, figs. 1–3.
1899 *Haplophragmium petiolus* Egger, p. 143, pl. 2, figs. 37–39.
1925 *Gaudryina oxycona* Reuss; Franke, p. 15, pl. 1, figs. 20*a*, *b*.
1928 *Gaudryina oxycona* Reuss; Franke, p. 143, pl. 13, figs. 8*a*, *b*.
1928 *Textularia trochus* d'Orbigny f. *subconica* Franke, p. 131, pl. 12, fig. 1.
1928 *Textularia trochus* d'Orbigny f. *typica* Franke, p. 131, pl. 12, fig. 3.
1937 *Marssonella oxycona* (Reuss); Cushman, p. 56, pl. 5, figs. 27–29; pl. 6, figs. 1–17.
1946 *Marssonella* cf. *oxycona* (Reuss); Schijfsma, p. 38, pl. 1, figs. 12*a*, *b*.
1953 *Marssonella trochus* (d'Orbigny); Barnard (*in* Barnard and Banner), p. 204, text-figs. 5*o–s*.
1957 *Marssonella oxycona* (Reuss); Hofker, p. 85, text-figs. 86–90.

Description. The conical test varies slightly in shape. During the initial growth-stages the early part of the test is conical with walls diverging at a wide angle as the diameter increases. This is often followed by a period when the diameter does not increase, and a cylindrical growth-stage is produced. Sometimes there is an abrupt increase in the diameter of the test, so that rapid expansion of the end-chambers produces a 'flanged' test. Often there is an abrupt halt in growth, which is then resumed, following a similar pattern as before; this gives the appearance of rejuvenation.

The globular proloculum is followed by whorls of five, four, and three chambers, before the biserial stage is reached. In conical forms the biserial crescentic chambers are overlapped by succeeding chambers.

The septa are usually flat, but can be concave, or convex, often with a slight depression towards the aperture. The face of the end-chamber varies in shape from semicircular, crescentic, to reniform. The aperture varies from its usual position, basal and flush with the surface of the test, to a vertical apertural face. Occasionally this is excavated and the aperture is almost hidden. The aperture is usually slit-like, but can be hemi-elliptical or reniform. The test is smooth with slight constrictions at the septa. The wall is composed of fine quartz grains set in a calcareous cement. Sometimes isolated specimens have up to five radial partitions developed in the last chambers only.

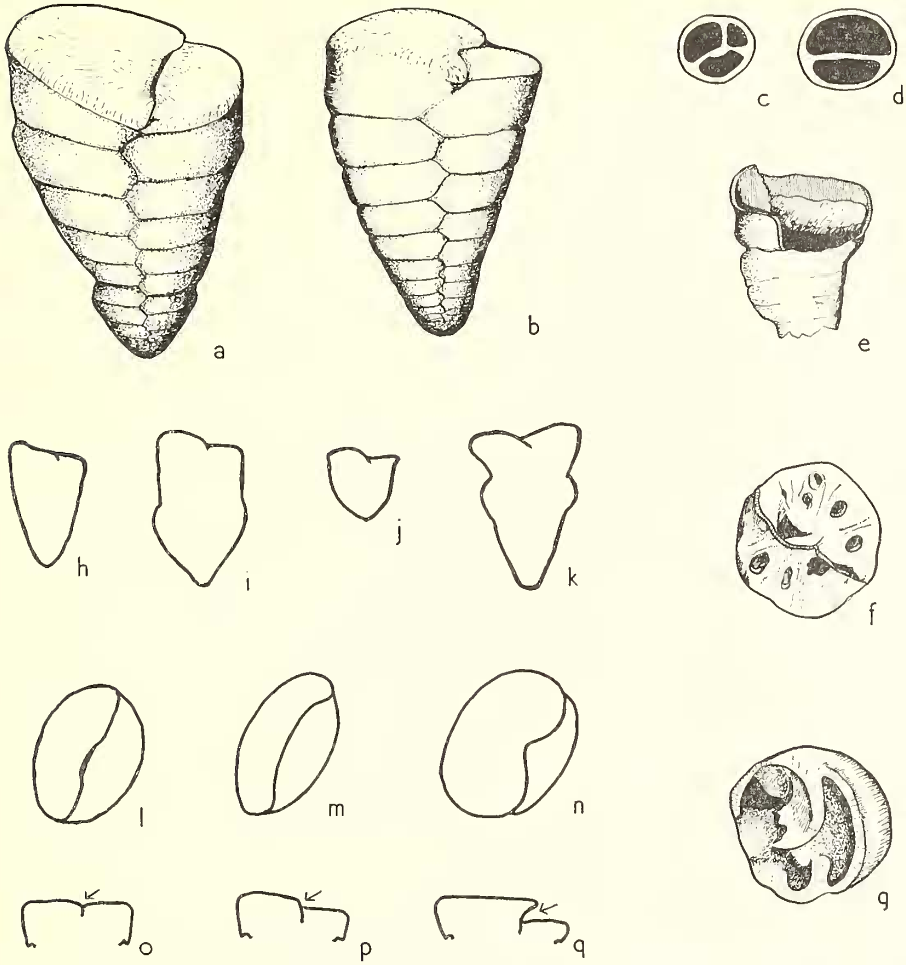
Locality of figured specimens. Whitlingham, near Norwich, Norfolk.
Horizon. Upper Chalk. *Belemnitella mucronata* zone.
Dimensions and hypotypes. P45015 (text-fig. 3*a*). Height 0·95 mm., diameter 0·84 mm. P45015 (text-fig. 3*b*). Height 0·95 mm., diameter 0·72 mm.

Marssonella conoidea (Marie)

Text-figs. 4*a–c*

1941 *Textularia conoidea* Marie, p. 63, pl. 2, fig. 20.

Description. The test is a regular blunt cone, which does not show a great deal of variation in shape. The initial stages are often a curved-sided cone; later the sides of the test become parallel so that it appears bullet-shaped. The cross-section is almost circular. A globular proloculum is followed by whorls of five to three chambers, but rapidly the

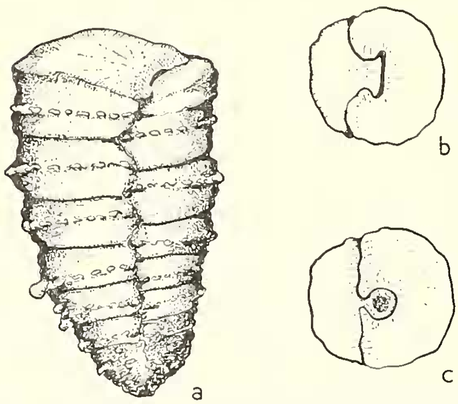


TEXT-FIG. 3. *Marssonella trochus* (d'Orbigny). *a*, *b*, ×90, from the Upper Chalk, *Belemnitella mucronata* zone, from Whitlingham, near Norwich, Norfolk, P45015. *c*, *d*, Showing the triserial and biserial initial stages of the test. *e*, A specimen showing the simple interior to the chambers with no radial partitions. *f*, Showing remnants of radial partitions in the interior of the shell. *g*, Showing chambers with normal simple interiors. *h*–*k*, Outline lucida drawings showing variation in the shape of the cones. *l*–*n*, Showing the variation in the shape of the apertural face. *o*–*q*, Showing the position of the aperture and the slope of the apertural face.

test becomes biserial. This initial part of the test is extremely difficult to interpret due to the rough surface. The wall of the test is rugose. In the initial part, coarse grains of quartz and sponge spicules are set in a thick calcite cement. However, in most of the test the coarse grains protrude above the surface of the cement. Characteristic of this species is that coarse grains appear to be arranged in a rough rib-like pattern, one rib above each suture. The sutures are in deep constrictions, and have flat, concave, or convex surfaces. Often the slit-like aperture is deeply set, almost covered by a lip-like extension of the chamber. In these forms there is a tendency for the chambers of one side of the test to develop, whereas those on the other decrease in size so that the test becomes almost uniserial, especially in forms where the aperture becomes central and deep, appearing to serve both sets of chambers.

Locality. H. Attock's Pit, New Catton, Norwich, Norfolk.
Horizon. *Belemnitella mucronata* zone.
Dimensions. Height 1·14 mm., diameter 0·76 mm.
Hypotype. P45017.

The development and stratigraphical occurrence of Marssonella. In 1953 the author drew attention (*in* Barnard and Banner 1953, p. 204) to the extreme variation which occurs in the size and shape of the test, as well as the shape of the final chamber and aperture. The species of *Marssonella* from the Chalk were thought (ibid.) to be one group; however, since then numerous specimens have been obtained from widely scattered localities as well as continuous sections, and it has become increasingly apparent that the group consists of a few species which prove to be of stratigraphical value.

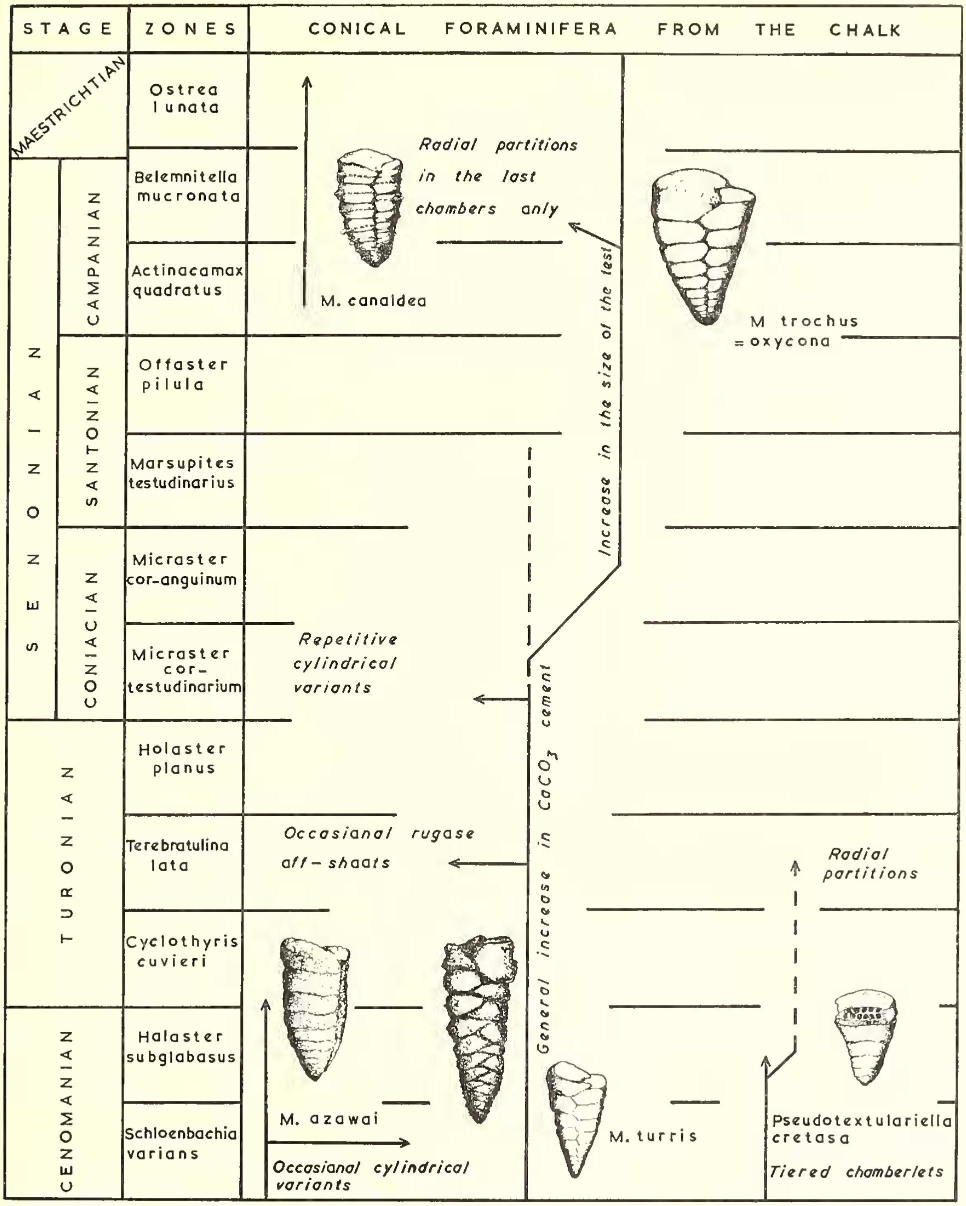


TEXT-FIG. 4. *Marssonella conoidea* (Marie). *a*, ×90, from the Upper Chalk, *Belemnitella mucronata* zone, H. Attock's Pit, New Catton, Norwich, Norfolk, P45017. *b*, *c*, Top view showing the sunken aperture; *b*, lipped and basal; *c*, circular and central.

At some horizons abnormally large forms are produced, at others the general character of the wall changes, so that an abundance of coarsely rugose forms is found. Text-fig. 5 shows in diagrammatic form the general history of the species of *Marssonella* and *Pseudotextulariella* (another conical form, although probably unrelated to *Marssonella*, is often confused with it) throughout the Chalk. Almost confined to the Cenomanian is *M. ozawai* Cushman, a large bullet-shaped species with a rugose wall. This species is easily separated from its contemporaneous, but longer-ranged form *M. turris* d'Orbigny. The latter is the root-stock of the species of *Marssonella* from the Chalk.

Marssonella turris d'Orbigny is usually an acute-angled cone, with a smooth wall. However, at certain horizons there is a tendency for the test to become rugose. Forms with coarser grains in the test generally occur in the Cenomanian, where the coarser silt-grade quartz is found in greater profusion than in higher levels in the Chalk. Generally there is a steady increase in the amount of calcareous cement as the species ranges into higher zones in the Chalk.

However, even here more rugose forms occur at certain levels, which can often be correlated with the size of the quartz grains in the Chalk. Although the test varies considerably in shape, two main trends occur. At some levels in the higher zones of its range there is a tendency for long, narrow, almost cylindrical variants to occur abundantly at sporadic horizons. Also at about the same time (*Micraster cor-testudinarium* zone), broader, blunter cones develop, which may be the forerunners of *Marssonella trochus* d'Orbigny and its synonymous form *M. oxycona* Reuss. In *M. trochus* d'Orbigny there is considerable variation in the shape of the test, as shown in text-figs. 3*h–k* and 3*l–q*. There is, however, a general tendency for the test to increase in size until the



TEXT-FIG. 5. Diagram showing the ranges and development of some conical foraminifera from the Chalk (Upper Cretaceous).

Belemnitella mucronata zone, where large specimens occur, several times the volume of earlier ones. Often in these forms the end-chambers increase abruptly in diameter so that the test appears to be flanged.

At some horizons isolated specimens have irregular radial partitions developed in the end-chambers only. This is rare, but gives a superficial resemblance to *Pseudotextulariella* *cretosa* Cushman, and its Turonian derivatives. However the absence of chamberlets in the later chambers and radial partitions in the early part of the test, separates the two forms.

Marssonella conoidea (Marie) occurs in the *Actinocamax quadratus* and *Belemnitella mucronata* zones, and although it resembles *M. ozawai* Cushman in shape, it is the only species of *Marssonella* from the Chalk which has a rib-like ornament composed of coarse quartz grains arranged in rough lines above the sutures. Also it has a much more regular test than other species.

Summarizing the history of the species of *Marssonella* from the Chalk, it may be stated that one main stock (*M. turris* d'Orbigny) occurs, giving rise, at later horizons, to blunt conical forms, which, when sorted by natural selection, produce such species as *M. trochus* d'Orbigny, and its large, often flanged variety, *M. oxycona* Reuss.

Genus PSEUDOTEXTULARIELLA Barnard 1953

Genotype. Textulariella cretosa Cushman.

In Barnard and Banner 1953, p. 198, the author proposed the genus *Pseudotextulariella* with the holotype *Textulariella cretosa* Cushman, specimens of which had been obtained by Cushman from the Cenomanian, at Barrington near Cambridge. Unfortunately, although the manuscript was sent in during 1952, it was not published until 1953. Since then Thalmann (1955, p. 53) has established that under Art. 25 of the International Rules of Zoological Nomenclature, *Pseudotextulariella* is legitimate.

The author has now had the opportunity of studying Cushman's specimens in the National Museum, Washington, and resulting from this work, certain points can be added to enable a more accurate definition of the genus. More information has also been obtained based on the study of the internal structures.

Pseudotextulariella cretosa (Cushman)

Plate 7, figs. 1–6, 8; text-figs. 6*a–d*, 7*a–f*, 8*a–c*

1932 *Textulariella cretosa* Cushman, p. 97, pl. 11, figs. 17–19.
1937 *Textulariella cretosa* Cushman, p. 61, pl. 6, figs., 26–28.
1948 *Textulariella cretosa* Cushman; Williams-Mitchell, p. 97, pl. 8, fig. 1.
1953 *Pseudotextulariella cretosa* (Cushman); Barnard (*in* Barnard and Banner), p. 198, text-figs. 6*b–i*.

Description. Test conical, broad or narrow, usually straight, but occasionally slightly arcuate, particularly at the initial end. Initial whorl triserial, following a globular or subglobular proloculum. A biserial arrangement of the chambers is soon established and

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EXPLANATION OF PLATE 7

Figs. 1–6, 8. *Pseudotextulariella cretosa* (Cushman). All specimens from the Cenomanian, Barrington, near Cambridge. Fragments of tests to show the distribution and development of the radial and horizontal partitions. 1, ×40. 2–6, ×45. 8, ×60.

Fig. 7. *Textulariella pacifica* Cushman. ×60. Recent, from the H.M.S. *Challenger* Expedition, St. 33, 435 fathoms, Bermuda, to show the development of the radial partitions and the central cavity. The partitions do not reach the centre of the test as in *Pseudotextulariella cretosa* (Cushman). BM No. 1962.3.16 1–2.

1 × 40

2 × 45

3 × 45

4 × 45

5 × 45

6 × 45

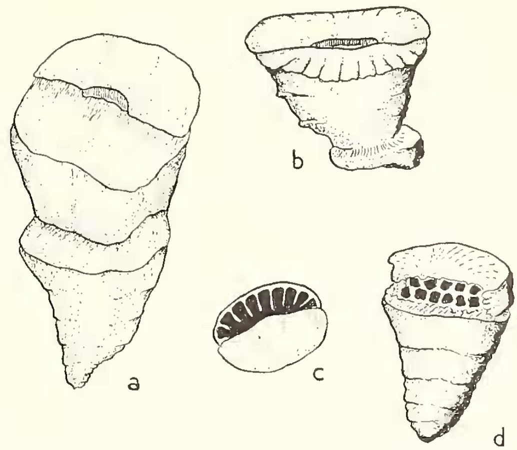
7 × 60

8 × 60

BARNARD, Chalk Foraminifera

remains for the rest of the test. The initial chambers are subglobular, but those in the biserial arrangement become almost semicircular to reniform in transverse section. The height of these chambers varies considerably so that the chambers may have almost parallel faces or sometimes they converge rapidly to become acutely pointed at the medial suture, where the chambers alternate. The height of the chambers varies from an eighth to a quarter of the diameter, and the sides of the test diverge at a constant angle. The walls separating the chambers are often marked at the surface of the test by strong raised ribs; however, on other specimens the sutures are either flush with the surface of the test or even slightly constricted.

In all the numerous specimens examined, the chambers, after the initial stage of the test had been passed through, are divided by an almost regular series of chamberlets. They occur arranged through the biserial portion of the test, and often become multiplied so that two to five tiers of chamberlets are developed. The chamberlets are developed progressively, and usually regularly, appearing at the surface of the test in weathered or decorticated specimens. With the application of water or clove oil to the surface of the test, the pattern of the chamberlets is often seen, and sectioning is not always necessary. The aperture is generally slit-like to reniform in shape, and may be flush with the surface of the apertural face or raised on a surface almost at right angles to the face of the chamber. In some forms irregular depressions occur in the apertural face from the periphery to the aperture.



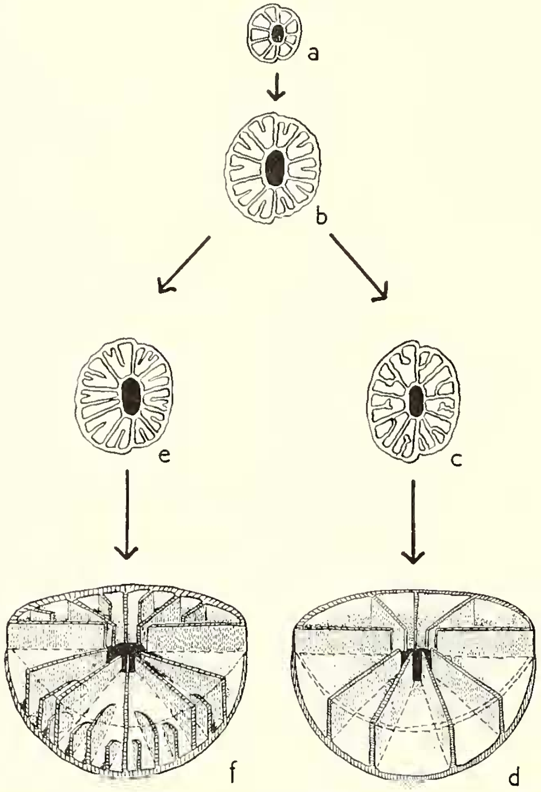
TEXT-FIG. 6. *Pseudotextulariella cretosa* (Cushman). All specimens in the U.S. National Museum, Washington, from the Lower Chalk, *Schloenbachia varians* zone, from Charing, Kent. *a*, 17624, holotype. *b*, 25295, holotype. *c*, *d*, 17625 paratypes.

Specimens. U.S. National Museum, Washington. 17624 (text-fig. 6*a*), holotype. 25295 (text-fig. 6*b*) holotype. 17625 (text-figs. 6*c*, *d*), paratypes.
Locality. Charing, Kent, England.
Horizon. Lower Chalk, *Schloenbachia varians* zone.

Development of the radial septa and chamberlets. Although somewhat irregular and variable, a progressive development of both the radial septa and tiers of chamberlets takes place in both ontogeny and phylogeny. The phylogeny, based on variation in successive populations occurring within the Cenomanian, is beyond the scope of the present paper. However, the general ontogenetic development is described below, and is shown in text-figs. 7 and 8.

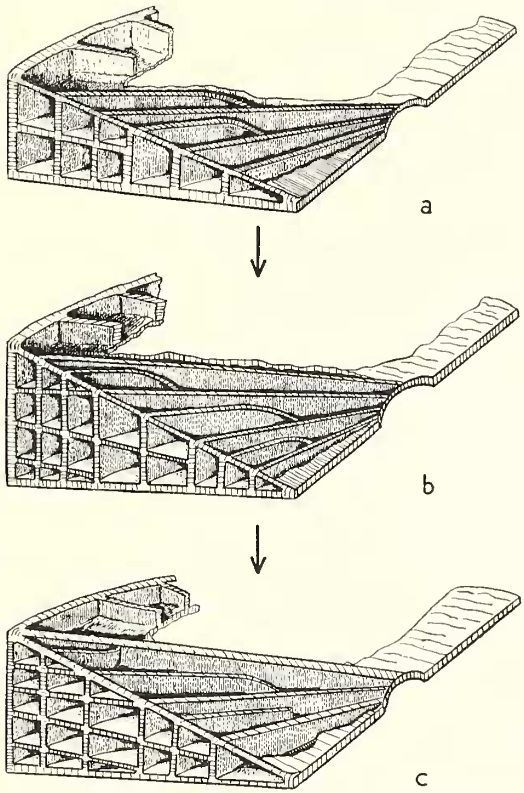
Two main trends in ontogenetic development are shown in text-figs. 7*a*–*f* in forms which only develop radial septa. Text-figs. 7*a*, *b*, *c*, *e* represent transverse sections of the biserial part of the test. Near the initial end (*a*) only a few vertical radial septa are formed, stretching from the periphery to join with a circular wall surrounding the apertural areas. This stage is rapidly followed by one in which the septa alternate in length, apparently forming two generations, one group reaching the circular central wall, whereas the other is shorter and confined to a small peripheral area.

This growth stage is shared by both main variants, but divergence now takes place



TEXT-FIG. 7*a–f*. *Pseudotextulariella cretosa* (Cushman). Diagrams to show the development of the radial partitions.

in later growth stages. In text-fig. 7*c* the septa again are in two main groups, a longer set reaching the centre, and the peripheral group as in earlier growth stages. However, the latter may do one of two things. Usually they elongate until coalescence with the central wall results, or they become bifid or irregular, and sometimes bend, joining the longer sutures about half-way to the centre of the chambers. Text-fig. 7*d* shows the regular development of a few radial vertical septa, when the smaller peripheral septa have reached the centre. In both text-figs. 7*d* and *f* the central circular wall has been omitted for clarity. In the other trend (text-figs. 7*e* and *f*) the primary vertical septa reach the central wall, but secondary and even shorter tertiary septa are formed and confined to the peripheral part of the test. Often the smaller tertiary septa are arranged irregularly and do not usually occur in the gap between every primary and secondary septa. Also these secondary and tertiary septa are not the same height for their whole length, but taper rapidly towards the lower chamber wall. Text-figs. 8*a–c* are block diagrams constructed to show development of tiers of chamberlets by the growth of not only vertical radial septa, but several generations of horizontal septa parallel to the chamber sutures. Text-fig. 8*a* shows a few primary radial partitions developed, with secondary alternating partitions coalescing. Near the periphery one horizontal secondary septum is formed, confined to the peripheral area and producing two tiers of almost rectangular chamberlets.



TEXT-FIG. 8*a–c*. *Pseudotextulariella cretosa* (Cushman). Block diagrams showing the development of the radial and horizontal partitions.

A further development is shown in text-fig. 8*b*, where further horizontal septa are added, one above and one below the earlier secondary septum. The latter has now grown to extend almost to the centre of the test, whereas the two later septa again are short and confined to the peripheral zone of the test. Text-fig. 8*c* shows an even further development with four secondary septa of varying length, producing five tiers of chamberlets.

THE AFFINITIES OF THE CONICAL FORAMINIFERA

The relationships and development of the conical foraminifera from the Cretaceous to Recent are of considerable interest and importance. In spite of the numerous publications in which mention of these forms is made, little is known concerning their affinities.

As well as the genera dealt with in detail in earlier parts of this paper, suggestions are made below as to the possible derivation of some other Cretaceous forms.

There are two root-stocks from which most of the genera of conical foraminifera may have been derived, namely *Marssonella* and *Arenobulimina*. *Marssonella* consists largely of a biserial arrangement of the chambers which rapidly follows an initial part made up of one or two whorls, composed of three, four, or five chambers. As has already been pointed out, at certain horizons in the Upper Senonian there is a tendency for isolated specimens to produce simple radial partitions dividing the chambers. It is considered that this tendency is repeated to some degree at least three times in the history of the group.

(*a*) In the Cenomanian *Pseudotextulariella* occurs, a genus in which complex internal structures are developed. Radial partitions stretch towards the centre of the test and then are united in a wall surrounding a central circular hole. Later horizontal partitions and further generations of chamberlets are added, resulting in a genus with extremely complex internal structures.

(*b*) In the Upper Senonian, forms develop with a few simple radial partitions only occurring in the end-chambers.

(*c*) A genus found in the late Tertiary to Recent is *Textulariella*, in which a thick zone of radial partitions develops in the wall-zone, and does not reach far towards the centre. This character serves to distinguish this genus from *Pseudotextulariella*.

It is considered that these groups are somewhat similar repetitive forms which converge towards a common plan of development, but which do not produce identical forms. Text-fig. 9 shows the suggested affinities of the various conical genera.

The initial coil in *Pseudotextulariella* suggests that it may have arisen from *Arenobulimina* (Barnard, *in* Barnard and Banner 1953). It is more probable, however, that *Marssonella*, *Pseudotextulariella*, and *Arenobulimina* have arisen at slightly different stratigraphical levels from either a common ancestor or closely similar ancestral stocks. Also the complex internal structures and the progression of these throughout the Cenomanian in *Arenobulimina* are closely parallel to those of *Pseudotextulariella*, and may show the close affinities between the two. It is probable that *Marssonella* is not the root-stock giving rise to *Pseudotextulariella*. *Arenobulimina* occurs first in the Albian in England and the evolution of this genus is the subject of a paper (Barnard and Banner) in preparation. In North America species of *Arenobulimina* appear to be few, and their history apparently terminates in Albian times, whereas in north-west Europe the genus continues and forms an important part of the Chalk faunas.

In the Albian of England there are a few species of *Arenobulimina* and these are associated with the argillaceous environments of the Gault clay and do not develop good internal structures. However, as soon as the Upper Greensand and Cenomanian facies, with their additional limestones, are encountered the internal structures develop in the species.

A form superficially similar to *Pseudotextulariella* is found abundantly in the Walnut Formation (Lower Albian) of Texas. This species, *Dictyoconus walnutensis* (Carsey), possibly related to a later Upper Cretaceous genus, *Colomia*, has recently been studied by Maync (1955).

Somewhat similar developments of chamberlets are shown in various groups of Cretaceous species belonging to the genera *Dictyoconus* and *Coskinolina* and those of